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LIQUID CRYSTAL DISPLAY AND MANUFACTURING METHOD THEREOF, AND DEVICE APPLYING IMAGE DISPLAY

[Abstract]

PROBLEM TO BE SOLVED: To suppress peeling of a columnar resin pattern and to decrease display irregularities by improving the adhesion degree of the columnar resin pattern to a substrate.

SOLUTION: In the liquid crystal display device, a resin film 15 is formed on a TFT array substrate 10 where a switching active element 4 to drive a pixel electrode is formed, and the switching active element 4 is brought into contact with a pixel electrode 2 formed on the resin film 15 through a contact hole 12, formed in the resin film 15. A columnar resin pattern 17 is formed to cover the contact hole 12

part, while the pattern fills the whole or a part of the contact hole 12, so that the columnar resin pattern 17 is formed overlapping the contact hole 12 part; and the adhesion degree of the columnar resin pattern 17 to the substrate is improved, as well as the level difference on the substrate surface is decreased, to prevent disturbance in the alignment of the liquid crystal caused by the level difference. Thus, high display quality without irregularities can be realized.

[Claim(s)]

[Claim 1] A LCD apparatus, wherein a resin layer is formed on a TFT array substrate on which a switching active element for driving a pixel electrode, the pixel electrode formed on the resin layer, and the switching active element are in contact by a contact hole formed on the resin layer, a cylinder-shaped resin pattern for forming a panel gap is formed between the TFT array substrate and a substrate facing the TFT array substrate, and liquid crystal is injected into the panel gap and the panel gap is sealed, is characterized in that the cylinder-shaped resin pattern is formed to cover the contact hole with some parts or the entire parts of the contact hole being filled.

[Claim 2] The LCD apparatus of Claim 1, wherein the resin layer is a color filter.

[Claim 3] The LCD apparatus of Claim 1, wherein a relationship of (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied.

[Claim 4] The LCD apparatus of Claim 2, a relationship of (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied.

[Claim 5] The LCD apparatus of any one of Claims 1 to 4, wherein a LCD type is a TN type.

[Claim 6] The LCD apparatus of Claims 1 to 4, wherein a LCD type is a IPS type.

[Claim 7] The LCD apparatus of Claims 1 to 4, an orientation process is performed by optical orientation.

[Claim 8] A manufacturing method of LCD apparatus is characterized in that a resin layer is formed on a TFT array substrate on which a switching active element for driving a pixel electrode, the pixel electrode formed on the resin layer, and the switching active element are contacted due to a contact hole formed on the resin layer, the contact hole is covered with some parts or entire parts of the contact hole being filled, and a cylinder-shaped resin pattern for forming a panel gap is formed between the TFT array substrate and a substrate facing the TFT array substrate.

[Claim 9] An image display application device having LCD apparatus of any one of Claims 1 to 7.

[Title of the Invention]

LIQUID CRYSTAL DISPLAY AND MANUFACTURING METHOD THEREOF, AND DEVICE APPLYING IMAGE DISPLAY

[Detailed Description of the Invention]

[Field of the Invention]

The present invention is related to a LCD apparatus and manufacturing method thereof, and an image display application device.

[Description of the Prior Art]

A LCD apparatus is a major display device, and in particular is used widely in the fields in which a small size and a light weight are required. As is shown in FIG. 5, a LCD apparatus is formed by sealing the liquid crystal 8 between a color filter substrate 10 on which a color filter pattern 5, 6 are formed, and an array substrate 11 on which a switching active element 4 is formed.

[Means for Solving the Problem]

Recently, as the liquid crystal is being applied to the fields using a conventional CRT, that is, the devices such as a large monitor, TV, and so forth, performance improvement of a LCD apparatus are being demanded more and

more. Especially, a medical application such as X-ray photo display, application of the liquid crystal panel in Internet commercial transactions are being progressed and a high quality LCD panel with high brightness and high precision in which there are no non-uniformity of display has been demanded. But, a conventional LCD panel has a shortcoming that high brightness and high precision can not be compatible because of shading created due to a black matrix formed on the color filter. Further, sufficient performance can not be exhibited in said applications since the non-uniform display is generated since the beads spacer used for panel gap control infiltrates into a color filter layer.

Under these circumstances, an attempt is being made to form a flat resin layer, and a color filter pattern on a TFT array substrate on which a switching active element for driving a pixel electrode is formed. Further, a brisk attempt is being made to form a cylinder-shaped resin pattern for forming a panel gap in advance on an opposing substrate such as a TFT array substrate on which a switching active element for driving a pixel electrode, or a color filter substrate.

But, in the panel formed by combining these two technology, it is proved that fine non-uniformity of display is generated.

As a result of reviewing in order to solve this problem, it is turned out that non-uniformity of display is generated due to following reasons.

That problem is due to non-uniformity of a gap created by peeling off of a cylinder-shaped resin pattern .

Accordingly, the object of the present invention is to provide a LCD apparatus and manufacturing method thereof, and an image display application device which improves adhesion of a cylinder-shaped resin pattern, suppresses peeling off of a cylinder-shaped resin pattern , and reduces the non-uniformity of display.

In order to solve above-mentioned problems, in a LCD apparatus set forth in the claim 1, a resin layer is formed on a TFT array substrate on which a switching active element for driving a pixel electrode, the pixel electrode formed on the resin layer, and the switching active element are contacted due to a contact hole formed on the resin layer, a cylinder-shaped resin pattern for forming a panel gap is formed between the TFT array substrate and a substrate facing the TFT array substrate, liquid crystal is injected into the panel gap and the panel gap is sealed, and is characterized in that the cylinder-shaped resin pattern is formed to cover the contact hole with some parts or entire parts of the contact hole being filled.

In this way, the cylinder-shaped resin pattern is formed to cover the contact hole with some parts or entire parts of the contact hole being filled. Therefore, the cylinder-shaped resin pattern is formed as a folded type on the contact hole, the

adhesion of the cylinder-shaped resin pattern is improved, surface faulting of a substrate is reduced and disturbance of liquid crystal orientation due to faulting is prevented.

A LCD apparatus set forth in the claim 2, in the claim 1, the resin layer is a color filter. Thus, since the resin layer is a color filter, it is possible to acquire the effect of the claim 1 in LCD apparatus of the color filter on-array type.

A LCD apparatus set forth in the claim 3, in the claim 1, a relationship, (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied. In this way, since a relationship, (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied, the hardness of the array substrate side of the cylinder-shaped resin pattern is stronger, and thus peeling off is not generated.

A LCD apparatus set forth in the claim 4, in the claim 2, a relationship, (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied. In this way, since a relationship, (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied, the hardness of the array substrate side of the cylinder-shaped resin pattern is stronger, and thus peeling off is not generated.

A LCD apparatus set forth in the claim 5, in a LCD apparatus described in

any one of the claim 1-4, a LCD type is a TN type. In this way, a LCD method can be applied to the LCD apparatus of TN type.

A LCD apparatus set forth in the claim 6, in a LCD apparatus described in any one of the claim 1-4, a LCD type is a IPS type. In this way, a LCD method can be applied to the LCD apparatus of IPS type.

A LCD apparatus set forth in the claim 7, in a LCD apparatus described in any one of the claim 1-4, orientation process is performed by optical orientation. In this way, orientation process performed by optical orientation can be applied to a LCD apparatus.

A manufacturing method of LCD apparatus set forth in the claim 8 is characterized in that a resin layer is formed on a TFT array substrate on which a switching active element for driving a pixel electrode, the pixel electrode formed on the resin layer, and the switching active element are contacted due to a contact hole formed on the resin layer, the contact hole is covered with some parts or entire parts of the contact hole being filled, and a cylinder-shaped resin pattern for forming a panel gap is formed between the TFT array substrate and a substrate facing the TFT array substrate.

In this way, a cylinder-shaped resin pattern for forming a panel gap is formed between the TFT array substrate and a substrate facing the TFT array

substrate so that the contact hole is covered with some parts or entire parts of the contact hole being filled. Therefore, the adhesion of the cylinder-shaped resin pattern on the substrate is improved, surface faulting of a substrate is reduced and disturbance of liquid crystal orientation due to faulting is prevented. Consequently, high-quality display which has no non-uniformity can be realized.

An image display application device set forth in claim 9 has a LCD apparatus described in any one of the claim 1-7. In this way, since an image display application device set forth in claim 9 has a LCD apparatus described in any one of the claim 1-7, LCD apparatus can be applied to an image display application device for which high quality LCD panel with high brightness and high precision in which there are no non-uniformity of display is required.

[Embodiment of the Invention]

The first embodiment of the present invention will be explained by referring to FIG. 1. FIG. 1 is a cross-sectional diagram of LCD apparatus according to the first embodiment of the present invention.

As is shown in FIG. 1, in this LCD apparatus, a flattening resin layer 15 is formed on a TFT array substrate 11 on which a switching active element 4 for driving a pixel electrode(a transparent electrode 2), the pixel electrode 2 formed on the flattening resin layer 15, and the switching active element 4 are contacted to a

contact hole 12 formed on the flattening resin layer 15, a cylinder-shaped resin pattern 17 for forming a panel gap is formed between the TFT array substrate 11 and an opposing substrate(a color filter substrate 10) facing the TFT array substrate, liquid crystal 8 is injected into the panel gap and the panel gap is sealed. The cylinder-shaped resin pattern 17 is formed to cover the contact hole with some parts or entire parts of the contact hole 12 being filled.

In this case, orientation process is applied to the array substrate 11 on which the flattening resin layer 15 is formed, and the color filter substrate 10, the cell gap is controlled by the cylinder-shaped resin pattern 17 positioned with a constant density. Two substrates 10, 11 for which the orientation process is performed with a sealing member 9 are bonded. Further, liquid crystal 8 is sealed with a sealing member 9. 2, 2' in the drawings are transparent electrodes, 3, 3' are polyimide orientation layers, 5 is a color filter pattern, and 6 is a black matrix. The cylinder-shaped resin pattern 17 is formed on the contact hole 12 so that a relationship, (contact hole diameter) < (cylinder-shaped resin pattern diameter) is formed. That is, The cylinder-shaped resin pattern 17 is formed integrally with a base section 17a embedded into the contact hole 12 , and the diameter of the cylinder-shaped resin pattern 17 formed above the contact hole 12 is set to be larger than that of the contact hole 12.

Next, a manufacturing method of LCD apparatus will be explained. A flattening resin layer 15 is formed on a TFT array substrate, the pixel electrode 2 formed on the flattening resin layer 15, and the switching active element 4 are contacted due to a contact hole 12 formed on the flattening resin layer 15, and a cylinder-shaped resin pattern 12 to cover the contact hole 12.

The second embodiment of the present invention will be explained by referring to FIG. 2. FIG. 2 is a cross-sectional diagram of LCD apparatus according to the second embodiment of the present invention. As is shown in FIG. 2, in the first embodiment, this LCD apparatus is a LCD apparatus of the color filter on-array type on which a color filter pattern instead of the flattening resin layer is formed, without a color filter pattern being not formed on the opposing substrate.

In this case, a color filter pattern 5, 6 is formed on TFT array substrate, orientation process is applied to a color filter on-array substrate 13 and the opposing substrate 14, the cell gap is controlled by the cylinder-shaped resin pattern 17 positioned with a constant density. Two substrates 13, 14 for which the orientation process is performed with a sealing member 9 are bonded. Further, liquid crystal 8 is sealed with a sealing member 9. 2, 2' in the drawings are transparent electrodes, 3, 3' are polyimide orientation layers, 5 is a color filter pattern, and 6 is a black matrix. The cylinder-shaped resin pattern 17 is formed on

the contact hole 12 so that a relationship, (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied.

Next, a manufacturing method of LCD apparatus is explained. A color filter pattern 5 is formed on a TFT array substrate 11, the pixel electrode 2 formed on the color filter pattern 5, and the switching active element 4 are contacted due to a contact hole 12 formed on the color filter pattern 5, and a cylinder-shaped resin pattern 12 is formed to cover the contact hole 12.

The first embodiment of the present invention will be explained. After a pattern of a flattening resin layer(PC335, JSR Corp.) is formed on TFT array substrate, a pixel ITO electrode pattern is formed by deposition. Next, a cylinder-shaped resin pattern(NN700, JSR Corp.) column type for forming a panel gap is superimposed in the contact hole of the flattening layer pattern, and two densities are formed on 3 pixels(FIG. 1). At this time, a pattern is formed so that (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is

observed by human's eyes. The result is listed in Table 1.

The second embodiment of the present invention will be explained. After a color register(CM7000, Whusi Film Allin Corp.) is formed on TFT array substrate by a spin coat method, and a color filter pattern is formed by exposing to a light and development. Next, a pixel ITO electrode pattern is formed by deposition. Next, a cylinder-shaped resin pattern(NN700, JSR Corp.) column type for forming a panel gap is superimposed in the contact hole of the flattening layer pattern, and two densities are formed on 3 pixels(FIG. 2). At this time, a pattern is formed so that (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human's eyes. The result is listed in Table 1.

The first comparison example of the present invention will be explained. As is shown in FIG. 3, after a pattern 15 of a flattening resin layer(PC335, JSR Corp.) is formed on TFT array substrate, a pixel ITO electrode pattern 2 is formed by deposition. Next, two densities are formed on 3 pixels so that a cylinder-shaped

resin pattern 7'(NN700, JSR Corp.) column type for forming a panel gap is not superimposed in the contact hole 12 of the flattening layer pattern 15. At this time, a pattern is formed so that (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied. Further, after an orientation layer pattern 3 is formed on the substrate 11 and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate 10 for which same orientation process is performed with the seal resin 9. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human's eyes. The result is listed in Table 1.

The second comparison example of the present invention will be explained. As is shown in FIG. 4, after a color register(CM7000, Whusi Film Allin Corp.) is formed on TFT array substrate 13 by a spin coat method, and a color filter pattern 5 is formed by exposing to a light and development. Next, two densities are formed on 3 pixels so that a cylinder-shaped resin pattern 7'(NN700, JSR Corp.) column type for forming a panel gap is not superimposed in the contact hole 12 of the flattening layer pattern 15. At this time, a pattern is formed so that (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied. Further, after an orientation layer pattern 3 is formed on the substrate 13 and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing substrate

14 for which same orientation process is performed with the seal resin 9. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by a human's eye. The result is listed in Table 1.

The third comparison example of the present invention will be explained. After a pattern of a flattening resin layer(PC335, JSR Corp.) is formed on TFT array substrate, a pixel ITO electrode pattern 2 is formed by deposition. Next, two densities are formed on 3 pixels so that a cylinder-shaped resin pattern (NN700, JSR Corp.) column type for forming a panel gap is superimposed in the contact hole of the flattening layer pattern. At this time, a pattern is formed so that (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied. Further, after an orientation layer pattern 3 is formed on the substrate and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by a human's eye. The result is listed in Table 1.

The fourth comparison example of the present invention will be

explained. As is shown in FIG. 4, after a color register(CM7000, Whusi Film Allin Corp.) is formed on TFT array substrate by a spin coat method, and a color filter pattern is formed by exposing to a light and development. Next, two densities are formed on 3 pixels so that a cylinder-shaped resin pattern 7'(NN700, JSR Corp.) column type for forming a panel gap is superimposed in the contact hole of the flattening layer pattern. At this time, a pattern is formed so that (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied. Further, after an orientation layer pattern is formed on the substrate and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by humans eyes. The result is listed in Table 1.

Table 1

diameter of a cylinder-shaped resin pattern	
diameter of a contact hole	
Evaluation result of non-uniformity	

In this embodiment, since some parts of a cylinder-shaped resin pattern 17 of the contact hole 12 is filled, the attachment hardness of an array substrate side of a cylinder-shaped resin pattern 17 is stronger(excellent fixed state is realized), and mechanical hardness is superb. Therefore, those advantages are preferable in terms of improvement of long-term reliability.

Further, in LCD panel which is small-sized and has high-precision, characteristics improvement is remarkable, and thereby solving a shortcoming such as the cost of the present invention. Thus, industrial values are judged to be very important.

Further, LCD method can be applied to a LCD apparatus of TN type or IPS type. In addition, orientation process(rubbingless : orientation is not performed by a mechanical means) can be performed by orientation.

Further, if the number of if theres are lots of spacers of the resin pattern(per unit space), low-temperature foams are generated, and if not, there is a problem in terms of a display performance because of a gap change created due to temperature change. Therefore, in connection with the number of a spacer of the resin pattern, optimum value is set according to a liquid crystal material, a spacer material or structure of a liquid crystal panel. It is designed such that the optimum value can be found through an experiment or a simulation.

Further, an image display application device can be formed by using a LCD apparatus having above-mentioned structure.

[Effect of the Invention]

According to a LCD apparatus described in the claim 1, the cylinder-shaped resin pattern is formed to cover the contact hole with some parts or entire parts of the contact hole being filled. Therefore, the cylinder-shaped resin pattern is formed as a superimposed type on the contact hole, and thereby, the adhesion of the cylinder-shaped resin pattern is improved, surface faulting of a substrate is reduced and disturbance of liquid crystal orientation due to faulting is prevented. Consequently, high-quality display can be realized.

In the claim 2, since the resin layer is a color filter, it is possible to acquire the effect of the claim 1 for a LCD apparatus of the color filter on-array type.

In the claim 3, since a relationship, (contact hole diameter) < (cylinder-shaped resin pattern diameter) is satisfied, the hardness of the array substrate side of the cylinder-shaped resin pattern is stronger, and thus peeling off is not generated.

In the claim 4, since a relationship, (a diameter of a contact hole) < (a diameter of a cylinder-shaped resin pattern) is satisfied, the hardness of the array substrate side of the cylinder-shaped resin pattern is stronger, and thus peeling off

is not generated.

In the claim 5, a LCD method can be applied to the LCD apparatus of TN type.

In the claim 6, a LCD method can be applied to the LCD apparatus of IPS type.

In the claim 7, orientation process performed by optical orientation can be applied to a LCD apparatus.

According to a manufacturing method of a LCD apparatus described in the claim 8, the contact hole is covered with some parts or entire parts of the contact hole being filled, and a cylinder-shaped resin pattern for forming a panel gap is formed between the TFT array substrate and a substrate facing the TFT array substrate. Therefore, the adhesion of the cylinder-shaped resin pattern on the substrate is improved, surface faulting of a substrate is reduced and disturbance of liquid crystal orientation due to faulting is prevented. Consequently, high-quality display which has no non-uniformity can be realized.

According to an image display application device set forth in claim 9, the device has a LCD apparatus described in any one of the claim 1-7, and can be applied to an image display application device for which high quality LCD panel with high brightness and high precision in which there are no non-uniformity of

display is required.

[Description of Drawings]

FIG. 1 is a cross-section of a LCD apparatus according to the first embodiment of the present invention.

FIG. 2 is a cross-section of a LCD apparatus according to the second embodiment of the present invention.

FIG. 3 is a cross-section of a LCD apparatus according to the comparison example 1.

FIG. 4 is a cross-section of a LCD apparatus according to the comparison example 2.

FIG. 5 is a cross-section of a conventional LCD apparatus.